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THE INSECTS OF 1992: A REVIEW OF PROBLEMS AND MANAGEMENT STRATEGIES

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Each growing season seems to be unique when we reflect back on the insects that captured our attention. This year, corn rootworms grabbed the limelight as probably the most economically destructive insect of the year. Corn flea beetles were early season problems in the southeastern region of the state, while thistle caterpillars fascinated us with their destructive potential on small soybeans.

Thistle Caterpillars in Soybeans

The thistle caterpillar was an early curiosity to many farmers and crop advisors across the state because of its defoliation of thistles; but, it also became a pest of soybean. During the last week of May, Tracy Cameron, agronomist at Crestland Co-op in Creston, reported massive numbers of caterpillars migrating from a thistle-infested alfalfa field, across a road, and into a neighboring soybean field where they began to defoliate. Chris Nelson, extension agriculturist in Adams County, reported that a field of seedling soybeans was eaten to the ground" and was later disced under and replanted. Large populations also were detected on either thistle or soybean in Cass, Cherokee, Dubuque, Franklin, Harrison, Marshall, Poweshiek, and Tama counties. It would not have been surprising if the insect was detected in every county of the state. From a historical perspective, the thistle caterpillar reached outbreak numbers in Iowa soybeans in 1966, 1968, and 1973, so it certainly had the potential of causing crop destruction.

The thistle caterpillar is the larva of the painted lady butterfly. It is a migratory species that flies into Iowa, usually in early summer, from the deserts of northern Mexico. This year it arrived in Iowa during mid April. It is an orange, brown, and white-spotted butterfly, about half the size of a monarch. The larvae are dark colored, covered with long black spines, and have small yellow spots along the sides of their body. Eggs are laid on plants and after hatching, the caterpillars web leaves together and live in the webbing until the leaf is defoliated. Development time from egg to adult depends upon temperature. When temperatures average 70°F, the larval stage is 29 days, at 80°F it is 16 days, and at 90°F it is 13.7 days. When caterpillars reach 1 1/2 inches in length, they are nearly full grown. Larvae will feed on more than 100 plant species, especially thistle and including crops such as soybean, sunflower, alfalfa, beans, and occasionally corn. Unfortunately, the thistle caterpillar is not considered to be a good biological control for thistles. Severe defoliation may reduce the number of seeds that a particular plant produces but it is very unlikely that their feeding will kill any thistles.

In soybeans, it is primarily an economically damaging pest during the early season. Economic thresholds are available for thistle caterpillars, but only for V3-V4 stage soybeans. Research conducted by Larry Pedigo at Iowa State University suggests that the economic threshold for stage V3-V4 soybeans would be one caterpillar per foot of row. This threshold is based upon leaf defoliation and not leaf webbing, which seems to have very little effect on yield.

Since most fields had not yet reached the V3-V4 stage, determining the necessity of an insecticide application was essentially subjective; if there were a lot of caterpillars feeding on small plants, then rescue treatments were justified. However, I suggested that the soybeans should be scouted to determine how far out into the field the caterpillars had moved and then the insecticide application should be applied only to those infested rows.

Although this insect had the potential to cause significant soybean stand loss, not every field was at risk. It was usually after the caterpillars had exhausted their thistle food source that they migrated in search of additional hosts. Therefore, soybean fields that were at the greatest risk of damage would have been adjacent to CRP land, pastures, alfalfa, ditches, or any similar situation that contained an abundant thistle population. If there were no thistles nearby, then the likelihood of a thistle caterpillar infestation in soybeans was very small.

The Second Generation. Second generation thistle caterpillars in soybean fields were widespread across north central, northeastern, and east central Iowa by mid July. Unlike the first generation larvae that migrated from thistle plants to nearby soybean fields, the second generation larvae came from eggs that were randomly laid throughout the field by painted lady butterflies. Defoliation was not concentrated on the border rows as it had been during the first generation but was scattered throughout fields. It didn't take long for the word to spread that an abundance of butterflies often suggested that defoliation could be found in nearby soybeans.

Scouting for the caterpillars was not a problem. They fed mostly in the top layer of leaves, and the caterpillars, or their webs, were very easy to see. Seldom were any found down inside the plant canopy.

Determining an economic threshold was a little more difficult. We know from research conducted by Larry Pedigo and his students at Iowa State University that a thistle caterpillar can consume about 43 square inches of soybean leaves, which is an area 6 by 7 inches. The caterpillar develops through 5 stages or instars and 97 percent of the total plant material eaten will be consumed during the last two instars. This past summer, I suggested two approaches to determining whether a field could economically benefit from an insecticide application; one was percentage defoliation and the other was insect density. In pod-setting beans, the maximum defoliation that could be tolerated would be 20-25 percent. When estimating defoliation, the entire planted should be pulled up and the percentage defoliation estimated for all the leaves. Defoliation would be more severe in the uppermost leaves because this is where the caterpillars are concentrated. Examining only the upper leaves would inflate the defoliation estimate. There is no research that has evaluated thistle caterpillar damage in flowering or pod-setting soybeans. Based upon what is known about other soybean defoliators, plus recent observations on thistle caterpillar densities and subsequent defoliation, I suggested that 10 caterpillars per foot of row in pod-setting soybeans would be an appropriate nominal threshold. This threshold should not be confused with the early-season threshold in V3-V4 beans which used one caterpillar per foot of row.

I know a number of soybean fields were sprayed for control of thistle caterpillars and these applications may or may not have been justified. Before an insecticide application is made, the question always needs to be asked, "Do I have a large enough population of caterpillars to reduce the soybean yield by an amount that would equal or exceed the cost of the treatment?" If the treatment cost is $12-14 per acre, then there must be enough caterpillars per acre to cause this much yield loss. If not, the insecticide will not provide an economic return.

I looked at a bloom-stage soybean field just south of Mason City on July 16 that had an abundance of caterpillars 1-1 1/4 inches long. The population size ranged from 1 to 13 caterpillars per 3 row feet and averaged 7.1. The farmer that owned the field was seriously considering spraying but after evaluating the amount of defoliation, he decided against it. I was convinced that he had made the correct decision, but I wanted some evidence. John Holmes, extension field crops specialist, and I selected 20 plots in the field, each 3 feet in length, where we counted all the thistle caterpillars on the plants. On both ends of each 3 foot plot, we removed soybean plants so that the caterpillars could not migrate along the row unless they left the plot and crawled across the ground to different plants. We felt that this was an adequate impediment for our purposes. The 20 plots were situated in pairs, such that one plot had all the thistle caterpillars removed, thereby simulating an insecticide application, and the caterpillars in the adjacent plot were allowed to continue feeding. Yields were taken from the plots in late September and calculated as bushels per acre. Where the caterpillars continued to feed and cause defoliation the yield was 62.4 bushels; where the caterpillars had been removed the yield was 61.4 bushels. No difference!

I am very sympathetic to the fact that a clear cut decision is not always easy to make regarding chemical control of insects, but the example above hopefully will give us just a little more insight into thistle caterpillars for future reference.

By mid July several people were finding webs that were empty and wondering why. There are two obvious reasons for this. First, a caterpillar will leave the web after it has completed feeding and form the pupa, known as a chrysalis. The chrysalis hangs from the underneath side of a stem on the plant. Second, caterpillars will also leave the web if they are diseased. I saw brown, limp, caterpillars hanging from leaves which was a good indication that naturally occurring diseases in the environment were providing a certain degree of biological control.

The Third Generation. Thistle caterpillars I collected from near Mason City pupated and began emerging as butterflies on July 22. Painted lady butterflies were now extremely abundant throughout many parts of Iowa during late July and raised the question as to whether there would be a third generation of these insects in soybeans. I didn't know for sure, but there was plenty of time for them to complete one more generation, assuming that temperatures warmed up and averaged 80 to 90 degrees. At these temperatures, the cycle from egg to adult would require about 26 to 22 days respectively.

By the first week of September, it appeared that most of the painted lady butterflies have departed from central Iowa. The butterfly-attracting flowers in my backyard did not have painted ladies nectaring on them during the last two weeks of August. So either they died or migrated south. But before this happened, females did lay some eggs in soybeans. I found 1/4 inch long thistle caterpillars in Boone County soybeans on August 13 and again on September 3. There were no reports of potential economically damaging populations late in the summer and soybeans were near the pod-fill stage where defoliation becomes less of a concern. When soybeans reach the R6 stage (full pod), defoliation levels would have to be near 30 percent before economic damage would occur.

Many insecticides are registered for use on soybean, but only carbaryl and permethrin are labeled specifically for thistle caterpillar. The labeled rates are: carbaryl (Sevin XLR Plus, 3 to 4 pints per acre) and permethrin (Pounce 3.2EC, 4 ounces per acre or Ambush 2E, 6.4 ounces per acre). Both Ambush and Pounce have a 60 day waiting interval before harvest; Sevin has a 0 day preharvest interval. Although I was not able to evaluate either of these products for thistle caterpillar control, both should be very effective.

Recommendations for 1993. Seedling soybeans adjacent to areas with large thistle populations should be scouted at mergence. A threshold of one caterpillar per foot of row through the V4 stage would be appropriate. Scout to determine how many rows from the edge of the field the caterpillars have migrated and spray only those rows. Soybeans in the blooming stages need 20-25 percent defoliation before economic yield losses occur. A nominal threshold of 10 caterpillars per foot of row could be used to determine the necessity of an insecticide. If webs are empty or diseased caterpillars are found, the field should not be sprayed.

Corn Flea Beetle Problems in Southeast Iowa

While most farmers were anticipating problems from the black cutworm, the corn flea beetle unexpectedly grabbed the spotlight as the first serious corn pest of the spring. Extension agriculturists Jim Frier, in Washington County, and Bob Dodds, in Lee County, reported damage to seedling corn from this insect. The insect is a small (1/16"), dark, pinhead-sized beetle that jumps rapidly when disturbed. They overwinter as adults and may be very common in winter wheat before corn emerges. The beetles feed on leaf tissue, stripping off the top layer of cells, leaving a pale or bleached spot on the leaf. Heavily infested leaves may turn gray, shrivel near the tip, and die. Damage is usually most severe during cold springs, when the corn growth is slow, thereby allowing the flea beetles a longer period during which they can attack seedling plants. Some of the most serious damage by this beetle is the spread of a bacterial disease known as Stewart's wilt. This disease can severely reduce yields on susceptible hybrids, lines, and sweet corn.

Most commercial corn varieties have resistance to Stewart's wilt. When beetles feed and introduce the bacteria into resistant plants, the infection usually does not spread throughout the plant. However, in susceptible plants the bacteria may spread throughout the vascular system. The concern then is the loss of leaf tissue caused by feeding from large populations of flea beetles. Because environmental conditions were not favorable during the seedling stage of growth, plants grew very slowly and were not able to outgrow the injury. Usually young corn plants can tolerate flea beetle feeding because they can produce more new leaf area than is being eaten. Fields that had plants with whitish or dead leaves, an absence of adequate soil moisture, and beetles still present on the plants probably were justified in spraying.

Larvae will feed on the roots of grain and grass plants, including corn, barley, oat, and wheat. They do not feed on alfalfa.

Purdue University suggests the following management guidelines for both dent (field) corn and seed corn fields. Prior to corn growth stage V4 on dent corn, control may be necessary if 50% of the plants inspected show severe flea beetle feeding damage (plants begin to look silvery or whitish, or leaves begin to die) and approximately 5 or more flea beetles per plant are found. In seed corn production, fields with inbreds known to be susceptible to Stewart's wilt should be carefully scouted for corn flea beetles. Prior to the V5 stage of development, control may be necessary if 10% of the plants inspected show severe corn flea beetle feeding damage and their numbers average 2 to 3 or more per plant. Once a corn plant reaches the V5 growth stage, it is no longer susceptible to significant flea beetle damage.

I examined the past eight volumes of the Insecticide and Acaricide Tests and there were no reports of insecticide evaluations targeted against flea beetles. Therefore, I do not have any data on insecticide performance against this insect. The following insecticides and minimum label rates are registered for use on corn for flea beetle control. Restricted-use insecticides are noted with an * and can be applied only by licensed applicators. Ambush* (6.4 ounces per acre), Asana XL* (5.8 ounces), Lannate L* (1 pint), Lorsban 4E (2 pints), Penncap M* (2 pints), Pounce 3.2EC* (4 ounces), and Sevin XLR Plus (2 pints).

Recommendations for 1993. Corn flea beetles are more likely if a mild winter is followed by a cool spring. Fields should be scouted if these conditions occur. Contact a seed corn company representative to determine if the hybrids or lines that are going to be planted are susceptible to Stewart's wilt. Use the thresholds stated above for field and seed corn.

Flea beetles should be relatively easy to kill with one of the insecticides listed above. I would suggest one that also would control black cutworms at the same time and that the product be banded over the row.

Corn Rootworms and Lodged Corn

Many thousands of acres of corn throughout Iowa experienced significant corn rootworm injury and lodging problems. Fields treated with granule insecticides at planting were observed with root damage ratings of 5 (two complete nodes removed to within 1 1/2 inches of the stalk) on the Iowa 1-6 scale. Knowing the exact cause in any particular field will be very difficult to establish. However, there are several reasonable causes that could provide an explanation to the problem. I will focus on several topics which are obviously strongly interrelated.

Winter and Spring Weather. Last December, January, and February were some of the mildest winter months on record. Corn rootworm researchers have known for some time that survival of rootworm eggs decreases with longer exposure to cold. If corn rootworm eggs are exposed to a week of temperatures in the low teens, especially in the absence of snow cover, this can reduce hatching by 50 percent. We simply didn't have an extremely cold winter that could have killed a larger percentage of the eggs.

Regarding spring weather, Gerry Sutter at the USDA lab in Brookings, South Dakota, has shown that if the soil is saturated for 16 days during egg hatch, then newly-hatched larvae fail to survive. He found that the highest survival rate occurred during the springs receiving the least amount of rainfall. In Iowa, rootworm eggs begin hatching in early June and this was an extremely dry month, which favored rootworm survival.

Last Year's Silking Dates. Late silking fields will occasionally attract large numbers of beetles from adjacent and more mature fields. Migration of additional beetles into a corn field will increase the egg population and subsequent larval population the next spring. As an example, a continuous corn field in northwest Iowa had moderate lodging and heavy rootworm injury (4-6 root ratings) in the field except for several border rows, which stood upright and had minimal rootworm injury. Last year, these border rows had been cut for silage during late July or early August. Therefore, there were no late-silking corn plants to attract immigrating beetles to lay their eggs in those rows that had been cut for silage. The area that was not cut for silage received eggs from both the resident beetles and the migrant beetles, which resulted in extensive damage this year.

Abundance and Occurrence. During the last two weeks of June, Iowa State University entomologists investigating corn rootworm damage in fields that were treated with soil insecticides at planting, noticed large numbers of larvae in the root systems. The ease, regularity, and abundance with which larvae were found led to speculation by some that egg hatch was delayed this season and soil insecticides had degraded before the larvae contacted them. It is unlikely that the timing of events in the corn rootworm life cycle had deviated very much from normal. Evidence from the literature and personal experience of Jon Tollefson, ISU corn rootworm researcher, can be used to support this hypothesis.

Researchers at the USDA Laboratory in Brookings measured the developmental rate of immature corn rootworms under controlled laboratory conditions. They reported it takes 13 days for larval development and 10 days for pupation to be completed at 77°F. Therefore, it takes nearly three weeks for beetles to emerge from the soil after eggs hatch; this is under constant temperatures that are likely to be warmer than June soil temperatures in Iowa. Researchers have been unable to show a significant relationship between calendar date or soil temperature and egg hatch. In Iowa, rootworm eggs can be expected to hatch around June 6. Adding 20 days to this date provides an estimated adult emergence date of June 26. A graduate student in entomology, Anne Warshaw, and I both found our first beetle on June 30. Considering the insect's development in the soil is somewhat delayed by cooler temperatures, these two dates (predicted versus actual) match very nicely. The June 30 discovery strongly suggests that corn rootworm egg hatch was not delayed in 1992.

This statement leads to the question, "If beetles emerged on June 30, why are there still larvae present in mid July?" A look at research conducted by Marlin Bergman in Indiana can be used to demonstrate that the occurrence is due to normal variability in occurrence corn rootworms. He used his estimate of the proportion of the population in a particular stage as indicators of when certain life stages occurred. For example, 50 percent occurrence represented peak numbers in a life stage while 10 and 90 percent occurrences represented points early and late, respectively, in the development of each stage. The occurrence of life stages showed a significant relationship to date and are presented in table 1 (modified from Bergman).

Table 1. Early, peak, and late occurrence of corn rootworm life stages.

Stage	Early (10%)	Peak (50%)	Late (90%)
2nd Instars	-----	June 25	July 7
3rd Instars	June 21	July 3	July 14
Pupae	-----	July 11	July 26
Adult Emergence	July 11	July 25	August 6

The table shows that late third instars occurred in mid July. By late July, the ease with which larvae could be found was really a function of the total number present in the soil. If population densities are low and only 10 percent remain in the larval stage, finding larvae will be more difficult. If population densities are high, even only 10 percent remaining as larvae will be a substantial number and their frequency, along with their size, will make detection much easier. Readily finding larvae in roots in mid to late July, therefore, should be an indicator that the density of the insect is high; this is supported by the substantial root feeding that was being observed in the fields, even though a soil insecticide is applied.

Insecticide Availability. Granular insecticides in low-moisture soil often are not readily dispersed off the granules, nor evenly distributed through the soil. Under this year's dry conditions in May and June, the efficacy of soil insecticides against rootworms may have been lower than normal.

Another factor which could influence the dry soil scenario is that when the rains finally arrived and helped distribute the soil insecticide, many rootworm larvae were already into the larger second and third larval stages. With most rootworm insecticides, it takes 2-4 times more chemical in the soil to kill third instars than it does to kill first instars. An insecticide that can control 90 percent of the first stage larvae in the spring (if adequate soil moisture is present) may not be nearly as effective against larger larvae in mid summer. The timing of the rainfall this growing season seems to have provided a distinct advantage to the corn rootworms.

Spring Weather. Dry weather during May and June restricted corn root development. Consequently, the corn plant's ability to tolerate some rootworm feeding was substantially reduced. Therefore, corn plants with small root systems that were extensively damaged did not have the root system necessary to remain standing during the windy, rainy weather of late July. With wet soil conditions, even undamaged plants may lodge during windy weather since saturated soils do not provide adequate support for the plant's root system.

Additionally, windy conditions during planting may displace, or blow, insecticides off the center of the row if the granules are being banded. Studies conducted by Marlin Bergman at Purdue University with Counter, Furadan, and Lorsban have shown that displacing the band of granular insecticide 6 inches to the side of corn rows significantly decreased the efficacy of Counter, but not that of Furadan or Lorsban. Root damage ratings also increased with wind velocity. Banded treatments behind the press wheels were most affected, but in-furrow applications that dispensed the granules near the ground were unaffected by wind up to approximately 20 miles per hour.

Recommendations for 1993. The corn rootworm problems of 1992 were essentially created by environmental conditions that favored the survival of rootworm eggs and larvae, but inhibited the activity of soil insecticides. With the exception of wind effects during planting-time applications, none of the other factors can be controlled or really anticipated.

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